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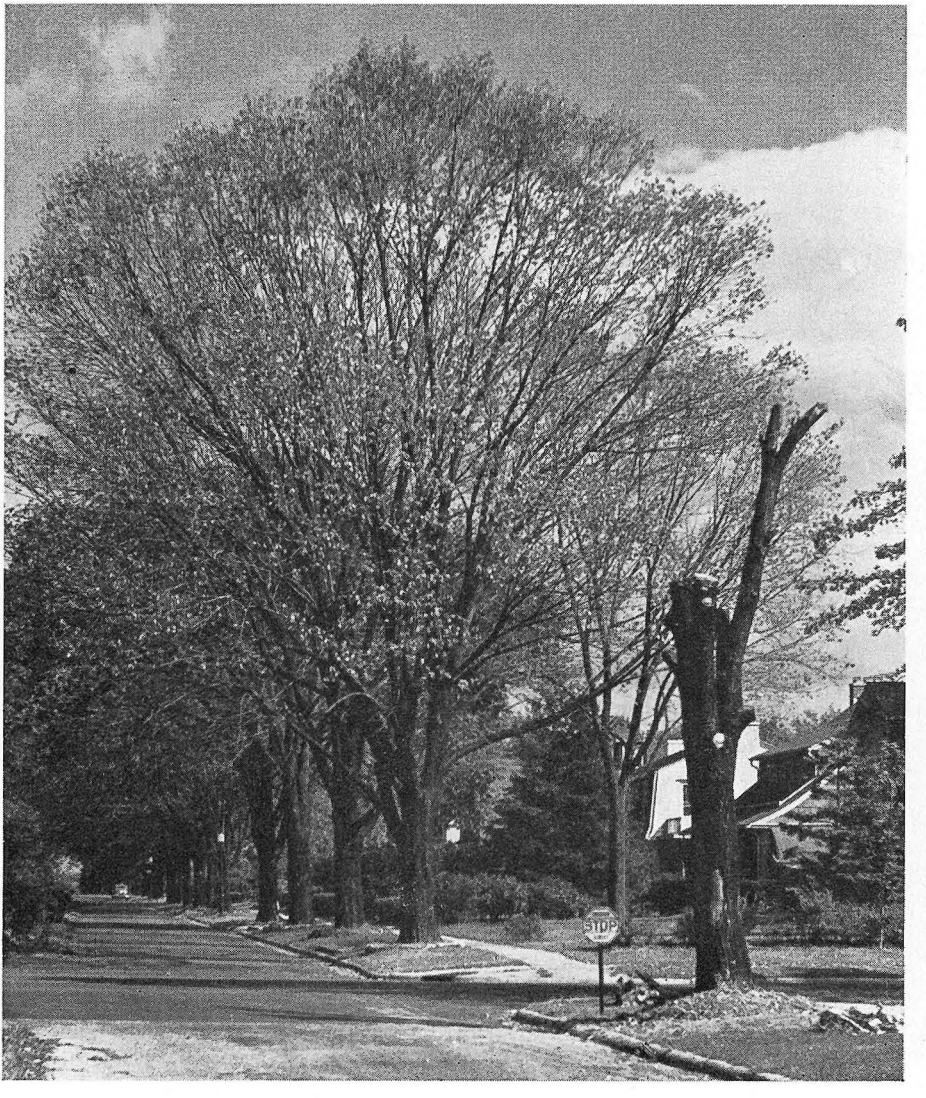
THE IDENTIFICATION AND CONTROL OF

ELM PHLOEM NECROSIS

AND

DUTCH ELM DISEASE



OHIO AGRICULTURAL EXPERIMENT STATION
WOOSTER, OHIO
In Cooperation With
THE UNITED STATES DEPARTMENT OF AGRICULTURE

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THE IDENTIFICATION AND CONTROL OF ELM PHLOEM NECROSIS AND DUTCH ELM DISEASE

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Elm phloem necrosis and Dutch elm disease have caused extremely heavy losses in many elm shade tree areas of the United States during the past 15 years. Both diseases are gradually spreading and may eventually become serious problems wherever elm has been used extensively in shade tree plantings. Although no cure is known for trees affected by either Dutch elm disease or phloem necrosis, measures can be taken to protect healthy trees from infection. This leaflet has been prepared as an aid to the identification and control of these two important shade tree diseases.

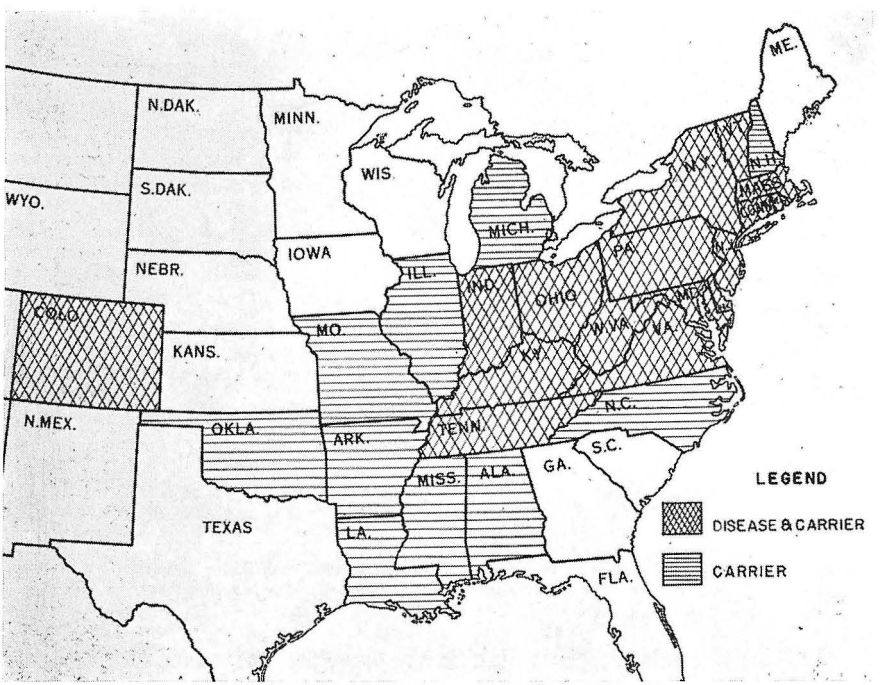

Figure 1—States in which Dutch elm disease has been found are shaded by crossed parallel lines. Additional states in which the principal bark beetle carrier of the disease occurs are shaded by single parallel lines.

Dutch elm disease was brought into the United States from Europe in imported elm logs. It has been known in this country since 1930. This disease is caused by the fungus **Ceratostomella ulmi,** which is commonly spread through the breeding and feeding habits of the smaller European elm bark beetle, **Scolytus multistriatus.** Spread of Dutch elm disease has been rapid in recent years. The present known distribution of the disease and its principal insect carrier are shown in Figure 1.

Elm phloem necrosis has occurred in the United States for many years. The disease is caused by a virus and is spread by the leafhopper, **Scaphoideus luteclus.** The area in which this disease is known to occur has gradually expanded. The states in which the disease and its insect carrier have been found are shown in Figure 2.

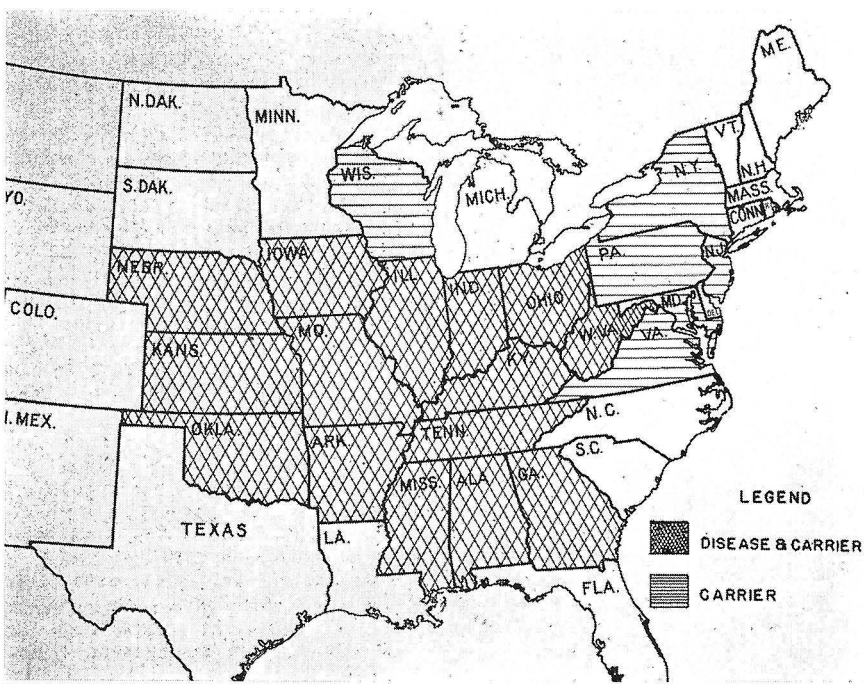

Figure 2—States in which elm phloem necrosis has been found are shaded by crossed parallel lines. The leafhopper carrier of the disease has been found also in states shaded by single parallel lines.

Phloem necrosis attacks and kills the American or white elm **(Ulmus americana)** and the winged elm **(Ulmus alata).** The commonly planted moline and vase elms, which are varieties of **Ulmus americana,** are extremely susceptible to it. In no case has a tree affected by phloem necrosis been known to recover.

ELM SPECIES AFFECTED

Dutch elm disease attacks all elm species and will kill all species commonly planted in the United States except the Siberian elm **(Ulmus pumila)** and the Chinese elm **(Ulmus parvifolia)**.

IDENTIFICATION

Neither phloem necrosis nor Dutch elm disease can be identified by the external, a.g. foliar, symptoms they produce. This is true because symptoms of the two diseases are not only similar but are easily confused with those caused by other diseases, mechanical injuries and some types of unfavorable growing conditions.

Dutch elm disease or phloem necrosis should be suspected whenever elm foliage suddenly wilts and the dry, dead leaves adhere to branches; or when the leaves on an entire branch, or throughout the top, turn yellow and fall prematurely. To determine whether the cause is phloem necrosis or Dutch elm disease, the procedure given on Page 6 should be followed.

Figure 3—Sampling a diseased elm for internal bark discoloration.

Elm Phloem Necrosis

1. Using a hand ax or a chisel as illustrated in Figure 3, cut through the bark of several buttress roots at several points around the lower trunk. Pry the bark from the wood surface so the inner bark can be examined.

If the bark layer in contact with the wood is white, the diseased condition is not caused by phloem necrosis. To determine if Dutch elm disease is the cause, see Step 1 under DUTCH ELM DISEASE.

If the inner bark surface is discolored the disease may be phloem necrosis. Phloem necrosis is indicated if the discoloration is yellow or more typically butterscotch, sometimes flecked with brown or black*, and the discolored tissue is confined to a very thin layer next to the wood. (See Figure 4.)

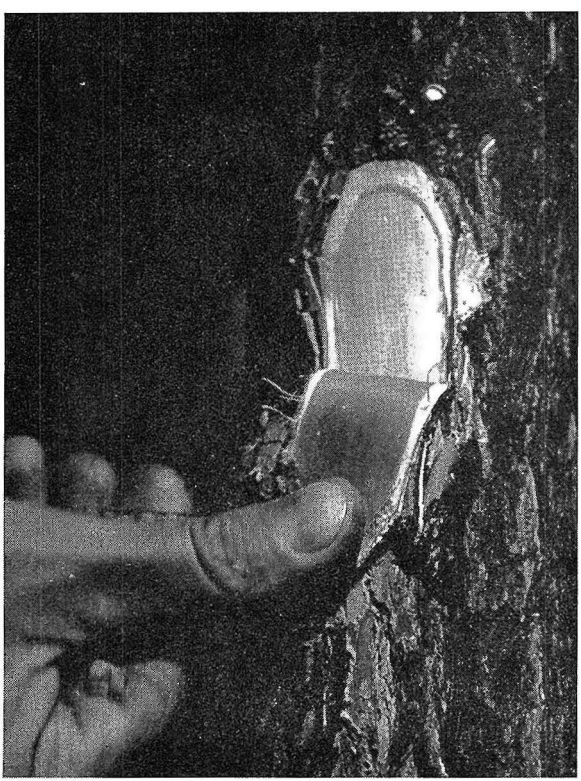

Figure 4 — Discoloration produced by phloem necrosis is confined to the thin bark layer in contact with the wood. The color is yellow to typical butterscotch, sometimes flecked with brown or black.

* The inner bark surface of normal, healthy elm is white. After a short period of exposure to the air, however, it, too, becomes discolored. The discoloration in this case is a reddish-brown and appears after the bark is peeled back, whereas the discoloration of phloem necrosis is a butterscotch color and present at the time the inner bark surface is exposed.

2. When discoloration of the inner bark indicates that the disease is phloem necrosis, remove a piece of the bark from the tree. Avoid bark completely dead or bark invaded by insects. From this piece of bark, strip the thin, discolored inner layer and confine it in a stoppered vial or the closed hand. The disease is phloem necrosis if a faint odor of wintergreen can be detected after confining the tissue in the closed hand or a stoppered vial for a few minutes. If the discoloration seems typical for phloem necrosis but the wintergreen odor is difficult to detect in the bark sample obtained, secure a new sample from another portion of the tree and confine it in a stoppered container for several hours in a warm place.

Dutch Elm Disease

If the diseased condition does not appear to be due to phloem necrosis, the following procedure is employed to determine if it is caused by Dutch elm disease:

1. Remove several small branches which have wilted, yellow or drying leaves. Avoid branches which have been dead for some time.
2. If the branches in cross section reveal brown spots or discoloration in one or more annual rings of the wood as illustrated in Figure 5, the disease is probably Dutch elm disease, Verticillium wilt or elm dieback.
3. Secure four or more branch specimens, about ½ inch diameter or larger and about 6 inches long, which contain discoloration of the wood as illustrated in Figure 5. These specimens should be wrapped

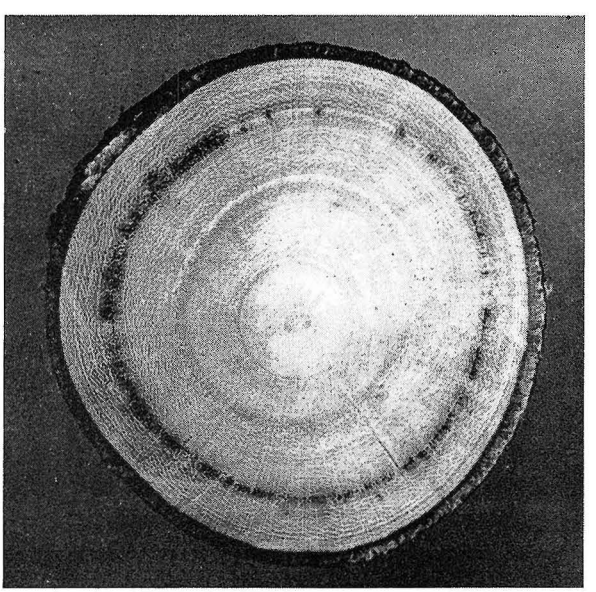

Figure 5 — Discoloration produced by Dutch elm disease as seen in a cross section of an infected branch. The color is brown and is confined to the wood.

to prevent drying and should be mailed, with a letter giving your address and location of tree, to your State Experiment Station; or, to

The Dutch Elm Disease Identification Laboratory
Bureau of Entomology and Plant Quarantine
503 Main Street, East Orange, New Jersey.

This is necessary because identification of the disease present requires a special laboratory procedure that involves isolation of the fungus obtained.

INSECT CARRIER

Both Dutch elm disease and phloem necrosis are spread by insects.

Dutch elm disease is spread by elm bark beetles, principally the smaller European elm bark beetle, **Scolytus multistriatus.** This beetle carries on its body the fungus that causes Dutch elm disease. The fungus is introduced into healthy elm trees by the adult beetles when they feed by chewing small holes in the twig crotches. The breeding activities of this insect are confined to dead, dying, or recently cut elm wood. Trees killed by Dutch elm disease or phloem necrosis create ideal breeding places for these beetles. The adults of the smaller European elm bark beetle are active during the entire elm foliar season. The most critical period for spread of Dutch elm disease, however, is in the spring.

Elm phloem necrosis is spread by a leafhopper, **Scaphoideus luteolus.** This small leafhopper feeds on the undersides of elm leaves by sucking out the plant juices. It is during this feeding on diseased and healthy trees that the virus causing phloem necrosis is obtained and subsequently introduced into healthy trees. The eggs of **S. luteolus** are laid in the outer bark of living elm trees and the winter is passed in this stage. The young or nymphs of this insect first appear about the time elm leaves first appear. They transform into adults 5 to 7 weeks later. Adults of this species are present in the field throughout the remainder of the summer.

CONTROL

Prevention of spread of these diseases to healthy trees depends upon preventing the insect carriers from feeding on these trees. This can be accomplished with spray containing DDT, provided they are correctly formulated, properly applied, and used in a sufficient quantity at the right time.

The following formulations, when diluted with water, have been found to be non-injurious to elm trees and to provide residues that will remain effective for long periods of time. These formulations were prepared in

the laboratory. Several of the commercially prepared DDT concentrates were found to be too injurious to elm trees when used at the required concentrations. Undoubtedly, many insecticide manufacturers will produce DDT emulsion concentrates, safe for use on elm at high concentrations, when the demand for them is made known.

Formula A

16 pounds of technical DDT dissolved in a mixture of 2¼ gallons of benzene and 1 gallon of Velsicol AR-50. To this solution add 1 pint of Triton X-100.

Formula B

16 pounds of technical DDT dissolved in 4 gallons of xylene. To this Triton X-100.

Formula C

20 pounds of technical DDT dissolved in a mixture of 5 gallons of xylene and 2½ gallons of Acme white oil. To this solution add 1½ pints of Triton X-100.

WARNING: Caution should be exercised in handling the DDT solvents as they are inflammable and concentrations of the fumes may be toxic. In handling the concentrated mixtures, care should be taken that they do not contact the skin for prolonged periods. Wash any exposed skin surface with soap and water soon after exposure.

These DDT emulsion concentrates may be stored for indefinite periods of time if kept in tightly sealed containers and in a warm place.

A Control for the Carrier of Dutch Elm Disease

The bark beetle carrier of Dutch elm disease inoculates healthy elm trees when it feeds in the twig crotches. To prevent this feeding **it is essential to spray thoroughly all bark surfaces.**

First Treatment

Apply spray **before** the appearance of elm flowers or leaves; complete bark coverage is **very** difficult after flowers or leaves appear. This period is usually March in the South and April in the North.

In hydraulic sprayers use formula A or B diluted with water to make 100 gallons.

In mist blowers use formula C diluted with water to make 20 gallons.

The average 50-foot elm tree will require 25 to 30 gallons of spray with hydraulic equipment or 2 to 3 gallons with mist blower equipment.

Second Treatment

Apply 2½ to 3 months after first treatment.

In hydraulic equipment use formula A or B diluted with water to make 200 gallons.

In mist blowers use formula C diluted with water to make 40 gallons.

Considerably more spray liquid will be required to properly cover each tree than was required at the time of the first treatment.

A Control for the Carrier of Elm Phloem Necrosis

The leafhopper carrier of elm phloem necrosis may inoculate healthy elm strees when it feeds on their leaves. To prevent this feeding **it is essential to spray thoroughly all leaf surfaces.**

First Treatment

Apply when elm leaves are full grown, usually May in South and June in the North.

Use same formulations and dilutions as given for secend treatment to control Dutch elm disease carrier.

Second Treatment

Apply when new elm foliar growth appears, usually 1 to 2 months after first treatment.

Use same formulations and dilutions as recommended for first treatment.

A Control for the Carriers of Both Elm Diseases

When the insect carriers of both Dutch elm disease and phloem necrosis are to be controlled **it is essential to spray thoroughly all bark and leaf surfaces.**

First Treatment

Use formulations, dilutions and timing of spray as recommended for first treatment to control the Dutch elm disease carrier.

Second Treatment

Same time, formulations and dilutions as recommended for the second treatment to control the Dutch elm disease carrier.

Third Treatment

Same time, formulations and dilutions as recommended for the second treatment to control the phloem necrosis carrier.

Control by Sanitation

In areas where Dutch elm disease is present it is a good practice to destroy all elm bark beetle breeding material, such as dead, dying, or recently cut elm wood. This material can be destroyed by burning or spraying thoroughly all bark surfaces with a solution of DDT in No. 2 fuel oil (8 pounds of DDT in each 100 gallons of oil). This type of control by sanitation will reduce the number of beetles in an area and reduce the chances of elm trees becoming infected. Elm bark beetles can fly several miles, and so for greatest effectiveness this type of control should be applied to relatively large areas.

Spider Mites

Red spiders or spider mites will often build up to damaging numbers on elm trees that have been repeatedly sprayed with DDT. These secondary pests can be controlled by adding Acme white oil to the emulsifiable DDT concentrates for use in hydraulic sprayers (formula A and B). The oil should be used at the rate of ½ gallon for each 100 gallons of dilute emulsion and used in treatments made when elm trees are in foliage.

Equipment

When hydraulic sprayers capable of pumping 50 gallons per minute at nozzle pressures up to 500 pounds were used, elm trees up to 80 feet in height were satisfactorily treated. Mist blowers having an output of 6,000 or more cubic feet of air per minute at a velocity of 120 miles per hour, and equipped to inject into this air stream 1 to 4 gallons of concentrated DDT spray per minute at 40 pounds pressure, have been equally as satisfactory for treating tall elm trees.

Sources of Spray Materials

DDT, technical grade—most insecticide and chemical companies.

Benzene, industrial grade—dealers in coal-tar products.

Xylene, industrial grade—dealers in coal-tar products.

Velsicol AR-50—Volsicol Corporation, 120 East Pearson St., Chicago, Illinois.

Triton X-100—Rohm and Haas Company, Washington Square, Philadelphia, Pennsylvania.

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ERRATA SHEET

Swingle, R. U., R. R. Whitten and H. C. Young. "The Identification and Control of Elm Phloem Necrosis and Dutch Elm Disease." Special Circular No. 80, April, 1949. Ohio Agr. Exp. Sta.

Page 4, second paragraph, third line: Change luteclus to luteolus.

last paragraph: Above this paragraph insert side heading Elm Species Affected.

Page 5, second paragraph, second line: Change a.g. to e.g.

Page 6, first paragraph, second line: Insert between the words roots and at the word or.

Page 8, eighth line: Between the words fungus and obtained insert the words from the discolored wood and the identification of the fungus.

under Control, first paragraph, third line: Change spray to sprays.

Page 9, Formula B, first line: After the word this insert the words solution add 1 pint of.

Page 10. under First Treatment, under A Control for the Carrier of Elm Phloem Necrosis, first line: Between the words in and South insert the word the.

under First Treatment, under A Control for the Carrier of Elm Phloem Necrosis, third line: Change the word secend to second.

Page 11, first paragraph, third line: Insert between the words or and spraying the word by.

under Sources of Spray Material, Velsicol AR-50: In address given, change Volsicol to Velsicol.

under Sources of Spray Material, between Velsicol AR-50 and Triton X-100, insert Acme White Oil--Standard Oil Company of Indiana, 910 South Michigan Avenue, Chicago, Illinois.